Chapter 27
Putting Personal Smart Spaces into Context

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ABSTRACT
The convergence between mobile telecommunications and the Future Internet opened the way for the development of innovative pervasive computing services. The self-improving Personal Smart Spaces (PSSs) are coupling next generation mobile communications facilities with the features provided by the static smart spaces to support a more ubiquitous, mobile, context-aware, and personalised smart space. Addressing the advanced requirements of PSSs regarding the establishment of a robust distributed context management framework is a challenging task. Evaluating such a system is not a straightforward process, especially when it is also based on comparative assessments of its performance, as various existing systems demonstrate different unique characteristics making the quantitative comparisons quite complex and difficult to accomplish. This chapter elaborates on a context modelling and management approach that is suitable for addressing the PSS requirements and provides experimental evaluation evidence regarding its performance.

INTRODUCTION
Pervasive computing is the third major era in computer science and aims to improve human experience and quality of life through ambient intelligence and smart spaces. In such environments users are served by interconnected smart devices without explicit awareness of the underlying communications and computing technologies. Towards this scope, there have been various research initiatives aiming the design and realisation of smart spaces (Lin & Jeng, 2013;
Wang et al., 2013; Tusor & Várkonyi-Kóczy, 2011; Spadacini et al., 2014) in homes, offices, universities, schools, hospitals, hotels, museums, and other private or public places, where various automation facilities support the users. In these cases, research has focused on developing techniques to support building automation, as well as mechanisms to adapt the behaviour of electronic devices, desktops and peripherals, etc. However, these services are bounded in fixed spaces and the provided functionality is only available in geographically limited environments resembling to independent “islands” of pervasiveness in a sea of legacy service provisioning systems. On the other hand, services provided to mobile users are raising different and more challenging problems that need to be resolved. (Hansmann et al., 2003; Huang & Mangs, 2008)

The notion of self-improving Personal Smart Spaces (PSS), detailed in (Roussaki et al., 2012), couples the facilities offered by next generation mobile services and communications with the features provided by the static smart spaces. A PSS will provide to its owner a more ubiquitous and personalised smart space that is able to follow the user wherever he/she goes. Each PSS consists of multiple devices, both mobile and fixed, owned and administered by a single user. In addition, it facilitates interactions with other PSSs, it is self-improving and is capable of pro-active behaviour. Intelligent and dynamic behaviour is realised based on a combination of context awareness and learning techniques. PSSs models and monitors their owner’s behaviour and environment in order to be able to adapt according to each time situation. Hence, context awareness is a crucial feature for the PSS’s overall functionality. A plethora of heterogeneous context sources provide data which need to be collected, disseminated, processed and managed in an efficient way. Various information related with user and device location, user profiles, movement patterns, user activities, time, network performance, temperature, ambient noise level, personal preferences are exploited by services in order to automatically adapt their behaviour based on the user situation, requirements and intentions. In (Roussaki et al., 2012) the characteristics of PSS’s context management component were presented. The component has been designed and implemented based on a set of requirements such as real-time control and management of the context sources; distribution of context information over heterogeneous networks and devices; inference of future or currently unavailable high level context information from raw context data based on various learning techniques; modelling, management, storage and processing of history of context data; support for privacy-aware access control facilities and secure distributed context event management mechanisms; etc.

The presented context management system has been tested in real situation environments with successful results. However, evaluating a context management system and providing a comparative assessment of its outcomes is not a straightforward process. Various context management systems demonstrate different unique characteristics making difficult the quantitative comparisons. In this chapter the evaluation process in terms of context data management performance is presented. More specifically, this chapter is structured as follows. The next section presents the privacy-aware context model that has been implemented in order to represent the context information utilised in PSS environments and the respective quality of context metadata captured. The description of the high-level distributed context management architecture follows. Subsequently, a literature review for context management performance evaluation approaches is presented. The following section elaborates on the experimental evaluation of the discussed context management system. Finally, conclusions are drawn and future plans are detailed.